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Botanical Composition and Nutritive Value of Cattle Diets on Southern Pine Range

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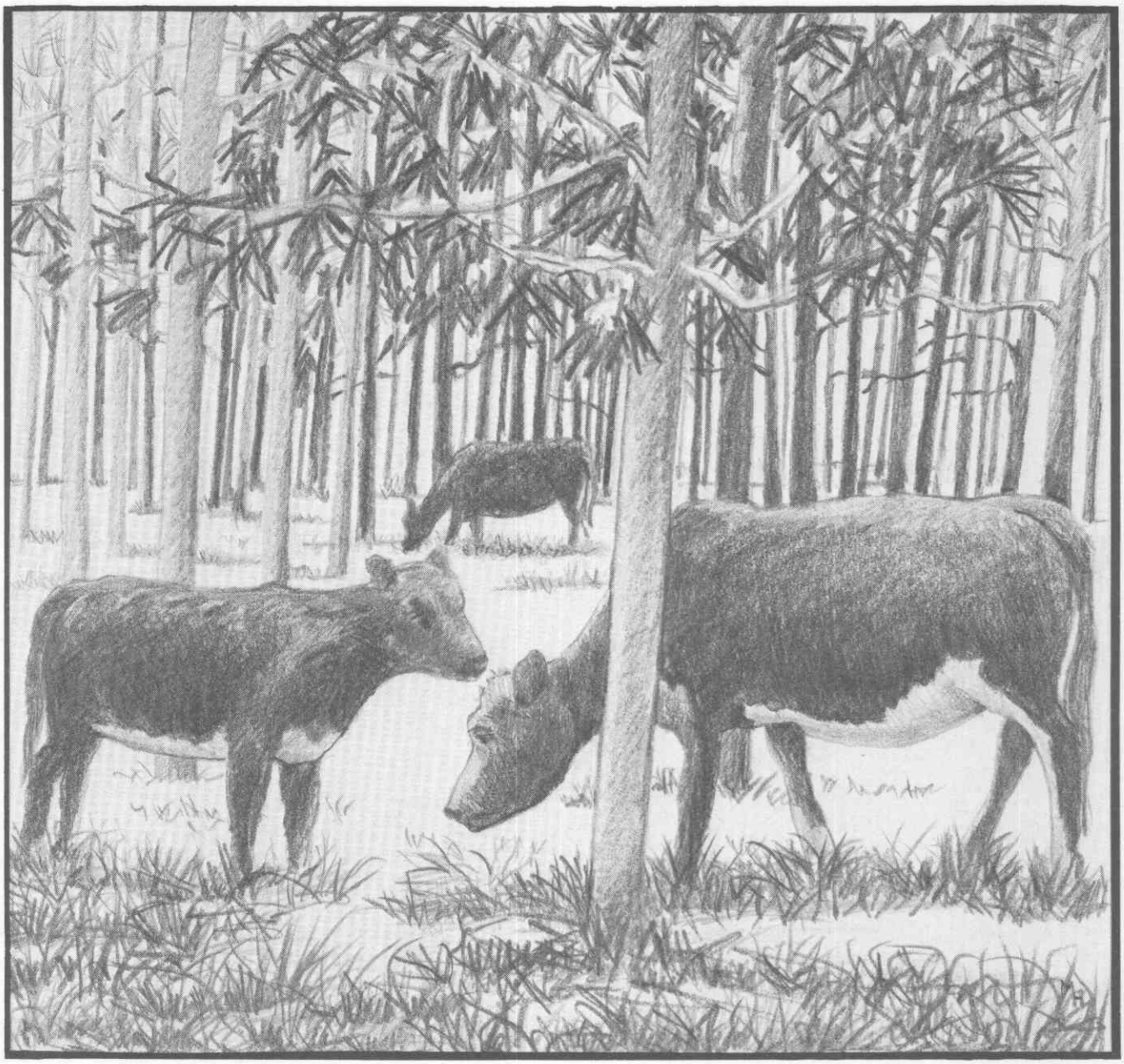

SUMMARY

The botanical composition of the cattle diet and the nutritive value of about 50 herbaceous and woody diet components were sampled on longleaf pine-bluestem range in Louisiana. The digestibility and nutritive values were highest in the spring when the forages were growing rapidly. Digestible energy and crude protein were insufficient for animal maintenance and growth from late fall through winter, and phosphorus was deficient yearlong. Calcium and vitamin A were sufficient to meet daily needs. The cattle diet was mainly grasses but included forbs, browse, and some pine needles. Daily intake of dry matter averaged 6 kg (13.2 lb) and daily animal weight gains were 0.3 kg (0.7 lb).

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INTRODUCTION

In previous years, forage evaluations focused primarily on protein and mineral components and less attention was given to digestible energy (Campbell et al. 1954, Duncan and Epps 1958, Duvall and Whitaker 1963). But energy is necessary for body functioning; it is used for maintenance of body heat, work, growth, fattening, and reproduction. Energy is provided mainly by carbohydrates and fats; proteins provide some energy, but only when the diet contains more than the animal needs for muscle and tissue formation (Stoddart et al. 1975). Digestible dry matter provides an index to the amount of energy available for animal maintenance and growth (Rittenhouse et al. 1971).

For cattle on southern pine range to thrive and reproduce adequately, feed supplementation is necessary, and maximum efficiency of cattle production can only be attained if specific seasonal nutrient deficiencies are known. To devise adequate supplementation programs, an animal's rate of dry-matter intake, diet composition and digestibility should be known. Intake rates for cattle are usually assumed to be about 7.5 kg (16.5 lb) per animal per day throughout the year (Campbell and Cassady 1951, Campbell et al. 1954), but range condition, forage quality and quantity, animal size and potential, season, and other factors influence amounts consumed.

The objectives of this study were to determine the botanical and chemical composition, digestibility, and seasonal dry-matter intake of the cattle diet on pine-bluestem range; this publication records these measurements for individual plant species and forage classes.

METHODS

Study Area

The study was conducted within a 52.6 ha (130-acre) pasture on the Palustris Experimental Forest in central Louisiana. Climate, soils, and topography are representative of the lower coastal plain (Duvall 1973). Annual precipitation averages 147 cm (58 in) and generally exceeds 10 cm (4 in) each month. Temperatures average about 10°C (50°F) in January and 30°C (85°F) in July. Both medium-textured slowly permeable soils and coarse-textured permeable soils are found in the pasture. The topography is generally rolling hills with slopes up to 10% with some poorly drained flats.

The pasture contains second-growth longleaf pine at about 23 m^2/ha (100 ft^2/acre) basal area; the original pine forest was cut more than 25 years ago. The dominant herbaceous vegetation is pinehill bluestem, and other important plants include other bluestems, panicums, and paspalums.[1]

Water was provided in corrals to make gathering the animals for sampling purposes easier. Beginning in 1970, one-third of the area was burned during late winter; burning was continued on a 3-yr rotation (1/3 every year) to provide succulent plant growth early in the spring.

Herd Management

Ten 8-mo-old heifer calves, ranging from one-quarter to one-half Brahman, were turned into the study pasture in September 1970, and grazed year-long. After the first year, the herd was reduced to six calves until the study was closed in March 1974. Burning ensured that cattle use of the pasture was rotational (Duvall and Whitaker 1964).

From November to May about 181 kg (400 lb) cottonseed cake or meal (41% crude protein) were fed per animal unit to supplement native forage deficiencies in energy and protein (table 1). Beginning in mid-January, about 1.8 kg (4.0 lb) per head of grass-legume hay was fed daily for about 60 days. Salt and steamed

[1]Scientific and common names of plants are listed in appendix table A-1.

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bonemeal (as a source of phosphorus) were provided free choice yearlong in separate covered containers.

Animals were weighed before and after each sampling period. Weight gains were computed from differences between weighings.

Sampling Procedures

Forage Quality and Digestibility.—Forage collections were analyzed chemically at the Feed and Fertilizer Laboratory, Louisiana Agricultural Experiment Station, Baton Rouge, using AOAC (Association of Official Analytical Chemists 1965) or other standard methods for proximate analyses of moisture, crude protein, ether extract, crude fiber, ash, and nitrogen free extract (NFE); and determination of phosphorus, calcium, and vitamin A (carotene). *In vitro* dry-matter digestibility (IVDMD) (Tilley and Terry 1963, Pearson 1970) and bomb calorimeter gross energy were determined for all forage and diet samples. Thirty to 40 samples were analyzed each month.

Table 1.—*Amounts of cottonseed cake or meal fed per animal-unit-day.*

Period	Daily schedule	
	kg	lb
November 1–30	0.5	1.0
December 1–31	1.1	2.5
January 1–March 10	1.4	3.0
March 11–31	0.9	2.0
April 1–May 31	0.5	1.0

Source: Pearson and Whitaker (1972).

Animal Diet Selection.—In March 1971, esphageal and rumen fistulas were installed. Three esophageal-fistulated animals were initially used to collect diet samples while one rumen fistulated animal provided rumen inoculum for the *in vitro* digestion analyses. One of the esophageal fistulated animals was omitted from the study after the first collection period because of fistula problems. Botanical composition and nutritive value of diets were determined from analyses of samples taken from fistulated animals, caged plots, and rectal palpations beginning in April 1971 and continuing through March 1974 (table 2). The range diets selected by the animals were estimated microhistologically from esophageal and fecal samples, and by comparison of plant composition inside and outside of exclosures (Johnson and Pearson 1981).

Freshly consumed forage samples were collected by esophageal sampling for 3 consecutive days at monthly to 6-wk intervals throughout the year (Harris et al. 1967). Animals were allowed to graze freely for approximately one hour or until about a gallon of forage was collected. The freshly consumed material was oven-dried for 48 hr at 50°C for subsequent chemical, digestibility, and botanical analyses. Botanical composition of esophageal samples was determined by gross morphological characteristics (Pearson 1976).

Table 2.—*Cattle diet sampling schedule, 1971–74.*

Sampling Schedule			Average sample date
1971–72	1972–73	1972–73	
...	Apr 19–21	...	Apr 20
May 26–28	May 24–26	May 10, 11, 14	May 21
Jun 23–25	Jun 28–30	...	Jun 27
Jul 21–23	Aug 2–4	Jul 25–27	Jul 27
Aug 25–27	Aug 30–Sep 1	...	Aug 29
Sep 29–Oct 1	Oct 4–6	Sep 19–21	Sep 28
Oct 27–29	Nov 8–10	...	Nov 3
Dec 15–17	Dec 13–15	Dec 5–7	Dec 12
Jan 26–28	...	...	Jan 27
Mar 1–3	Feb 14–16	Mar 6–8	Feb 27

Forage samples were collected at the same time that animal-diet samples were taken. Samples included major forage species that we saw cattle eating. A 100 g (dry wt) sample of each species was collected from five plants. The stage of leaf and flower development of the major grasses, forbs, and browse was recorded on each collection date.

Sixty permanent sampling points were randomly located within the pasture; 20 in each of the 3 prescribed burning units. Forage utilization and production were determined from paired 0.89 m^2 (9.6 ft^2) plots by the plucked-quadrat method (Grelen 1967). The location of one of the paired plots was systematically rotated around the permanent sampling point each year to avoid sampling identical plots from year to year. Plots were paired in March of each year on the basis of similar herbage composition; the pairs were within 6.1 m (20 ft) of each other but not closer than 1.8 m (6 ft). The plot to be caged was randomly selected. Herbaceous species within caged plots were periodically plucked to the same height as their paired grazed plot; the remainder was clipped to ground level in February or early March. Annual production was obtained by summing the clippings. Clipped forages were oven-dried at 100°C for 48 hours.

Dry Matter Intake Rate.—Fecal samples were collected from the rectum of six intact animals during the first year to calculate dry matter intake (DMI); only three of the intact animals were used in subsequent years because the pasture lacked sufficient grazing capacity for more animals.

Thirty grams of a chromic oxide (Cr_2O_3) and purified cellulose mixture (1:2 ratio) in a gelatin capsule were administered with a balling gun to each of the intact animals each morning for 8 days. During the last 3

days, total fecal output was computed from chromic oxide-feces ratios and a fecal subsample was saved for chemical analyses. Chromic oxide is an external indicator that is not digested as it passes through the animal digestive system. Fecal samples were measured for chromic oxide by methods described by McCann and Theurer (1967). DMI was estimated according to Theurer (1970):

$$\text{Fecal output (kg)} = \frac{\text{kg } Cr_2O_3 \text{ administered}}{\text{kg } Cr_2O_3\text{/kg fecal dry matter}}$$

$$\text{DMI (kg)} = \left(\frac{\text{Fecal output (kg)}}{100 - \%\ \text{IVDMD}} \right) 100$$

RESULTS AND DISCUSSION

Phenology

Plant phenology is a useful guide to forage quality, since both nutritive value and palatibility change as a plant matures. For instance, young plants usually have higher nutritive values than mature plants. Phenological stage (flowering, seeding, and maturation) of the forages varied throughout the year (table 3 and appendix tables A2-4).

Most of the grasses exhibited similar phenological development since they were mainly warm-season growers, although panicums and carpetgrass did not always conform. For instance, most grasses were in the young-leaf stage during spring when panicums and carpetgrass were in full-leaf and early seed development with some seed maturing and disseminating. During summer, most grasses were in the full-leaf and boot stages while carpetgrass and panicums disseminated seed throughout. During fall, all grasses were in the full- to-mature-leaf stage with seed disseminating. In winter, grasses were generally dormant and dry, while panicums had young leaf growth in February.

Forbs were generally in early- to full-leaf stages during spring, mature leaf and seed ripening during summer, disseminating seed in fall, and dry or dormant during winter. Ragweed woollywhite was earlier in development and maturation while swamp sunflower matured later. By fall, ragweed woollywhite, southern bracken, and slender rosinweed were mature and dry when most other forbs were in full-leaf stage and disseminating seed.

Woody plants were generally in the full-leaf stage and developing seed from mid-spring through summer; seed ripening, fruit dropping and fall colors generally occurred before winter. American beautyberry and common greenbriar did not begin seed development until summer while Elliott blueberry began dropping fruit in late spring. Early leaves and flower buds were generally apparent by late winter.

Table 3.—*Phenology of plant groups on the Palustris Experimental Forest, 1971–74*

Average sample date	Grasses	Forbs	Woody
April 20	young leaf with some early seed formation	early leaf	early leaf and seed developing
May 21	young to full leaf and early seed formation	early to full leaf with flowering	full leaf and seed developing
June 27	full leaf with seed ripening	full leaf with seed ripening	full leaf and seed developing
July 27	full leaf with seed disseminating	full to mature leaf with seed ripening	full leaf and seed developing
August 29	full to mature leaf and seed disseminating	full to mature leaf with seed ripening and disseminating	full leaf and seed developing
September 28	full to mature leaf and seed disseminating	full to mature leaf with seed disseminating	full leaf and seed ripening
November 3	mature leaf and seed disseminating	plants mature, winter rosette showing	full leaf to fall color and fruit ripe to dropping
December 12	plants dry and dormant	plants mature	fall color and fruit dropping
January 27	plants dry and dormant	dry plants with winter rosettes	leaf fall complete and some flower buds
February 27	plants dry and dormant	dry plants with winter rosettes	early leaf and flower buds

Table 4.—*Dry matter intake (DMI) and in vitro dry matter digestibility (IVDMD) of cattle*

Average sample date	Intake							
	1971–72		1972–73		1973–74		Average	
	DMI	IVDMD	DMI	IVDMD	DMI	IVDMD	DMI	IVDMD
	kg/day							
April 20	. . .	. . .	7.2	3.2	. . .	. . .	7.2	3.2
May 21	2.8	0.6	10.1	4.6	9.2	3.9	7.4	2.7
June 27	4.8	2.0	8.3	3.1	. . .	. . .	6.5	2.6
July 27	4.1	1.2	8.2	3.1	6.8	2.5	6.4	2.2
August 29	3.6	1.0	8.1	3.2	. . .	. . .	5.9	1.9
September 28	4.9	1.9	6.6	2.1	7.9	2.5	6.5	2.2
November 3	4.6	1.0	5.6	1.4	. . .	. . .	5.1	1.2
December 12	3.3	0.6	5.9	1.0	5.9	1.5	5.0	1.0
January 27	3.8	0.9	. . .	. . .	. . .	. . .	3.8	0.9
February 27	. . .	. . .	4.2	0.8	5.9	1.8	5.1	1.3
Average	4.0	1.2	7.1	2.5	7.1	2.4	6.0	1.9

Dry Matter Intake and Gain

Daily dry matter intake (based on the chromic oxide-fecal output-IVDMD procedure) varied from 2.8-10.1 kg (6.2-22.2 lb) (table 4). The average daily intake for the 3 yr was 6.0 kg (13.2 lb). Average animal body weight was 375 kg (827 lb) and varied during the study from 288-440 kg (635-970 lb). Daily gains averaged about 0.3 kg (0.7 lb) and varied from losses of 0.8 kg (1.8 lb) in December to gains of 1.4 kg (3.1 lb) in June (table 5). Severe weight losses during December indicated a need for additional intake of energy and/or protein. The late fall and winter are especially critical for pregnant cows which are in late stages of gestation.

The *in vitro* digestible dry matter-weight gain relationship can be expressed as the equation: $g = 0.276\ DDMI - 0.296$ where g is daily gain in kg and DDMI is daily digestible dry matter intake in kg. The coefficient of determination was 0.31.

Table 5.—*Average cattle gains*

Average sample date	Gains			
	1971–72	1972–73	1973–74	Average
	kg/day			
April 20	. . .	0.8	. . .	0.8
May 21	. . .	0.9	0.5	0.7
June 27	1.4	0.9	. . .	1.2
July 27	0.5	0.4	0.9	0.6
August 29	0.4	0.3	. . .	0.4
September 28	0.5	−0.3	0.4	0.2
November 3	0.2	−0.4	. . .	−0.1
December 12	−0.6	−0.4	−0.8	−0.6
January 27	−0.1	. . .	. . .	−0.1
February 27	0.1	0.1	0.2	0.1
Average	0.3	0.3	0.2	0.3

Nutrient Analyses

Digestibility and Energy.—Cattle diets were generally most digestible during spring when forages were growing rapidly (table 6 and appendix tables A2-4). The two diet-sampling techniques (cage and esophageal) yielded similar digestibility estimates during most of the year, but in spring cattle selected a less digestible diet and in winter a slightly more digestible diet than was indicated by the cage method. Since IVDMD is generally below 50%, energy deficiencies are suspected. Although these digestions appear low, hay samples averaged 52% IVDMD which is comparable to the National Research Council (1970) values for total digestible nutrients (TDN).

Table 6.—*In vitro dry matter digestibility of forage classes and cattle diets*

Average sample date	Digestibility				
	Grasses	Forbs	Woody	Cage	Esophageal
	percent				
April 20	53.1	42.4	41.6	53.4	44.8
May 21	43.4	37.8	33.3	51.9	36.4
June 27	36.4	35.3	28.8	40.5	39.7
July 27	36.9	33.1	30.0	37.2	34.1
August 29	33.9	33.9	30.2	36.2	32.7
September 28	30.2	32.2	28.8	33.2	34.2
November 3	25.4	27.9	31.7	26.2	22.9
December 12	17.5	21.6	26.4	23.2	20.2
January 27	15.4	22.0	26.4	18.9	24.5
February 27	18.7	32.8	25.9	16.8	25.6

Gross energy in the cattle diet varied little during the year (table 7). However, digestible energy (DE) is the important component relative to animal production. Energy values are usually reported in terms of net energy (NE), metabolizable energy (ME), total digestible nutrients (TDN), dry matter digestibility (DMD) or DE. Digestible ether extract, digestible crude fiber and digestible NFE are measures of the digestible fat and carbohydrate content of feed material; these along with digestible crude protein provide a basis for determining TDN. Energy deficiencies result in reduction or cessation of growth (including skeletal growth), loss of body weight, failure to conceive, and increased mortality (National Research Council (NRC) 1970).

During the year ether extract, crude fiber, and NFE varied slightly among sampling periods and forage classes. For instance, ether extract in grasses averaged 2–3%, in forbs 3–4%, and in woody plants 5–7% (appendix tables A2-4). Crude fiber in grasses averaged 30–37%, in forbs 21–40%, and in woody plants 20–35%. Nitrogen-free extract in grasses averaged 45–50%, in forbs 40–58%, and in woody plants 48–56%.

The TDN maintenance requirement of 375 kg (827 lb) heifers or mature cows is about 0.8% of body weight or 3.0 kg (6.6 lb) (National Research Council 1970). If IVDMD can be considered an estimate of TDN, the average TDN intake by the cattle in this study did not meet NRC maintenance requirements except in April (table 4). However, since animals in this study generally gained weight except during the fall and early winter (November–February), the intakes must have been underestimated in comparison to the NRC requirements. It is not known whether fecal output, digestibility or both were underestimated, but this is similar to results reported by Prates et al. (1975).

To better evaluate energy needs, daily intake requirements based on metabolic animal weights were determined from the *in vitro* digestible dry matter intake (DDMI) and cattle gain data. These requirements are described by the equation: $DDMI = 0.0203\ w^{3/4}(1 + 0.621g)$ where w is the mean body weight in kg at the start of the gain period and g is daily gain in kg. The constant (¾) was assumed (Garrett et al. 1959). The coefficient of determination was 0.34. Consequently, the estimated TDN intake (from DMD) for maintenance of 375 kg cattle was 1.7 kg or about 0.5% of body weight. With this intake requirement the cattle generally exceeded their daily TDN requirements for maintenance except during the period from November through February. If weight losses are to be minimized, a supplemental feeding program similar to the one described earlier (Pearson and Whitaker 1972) should be administered. These TDN or DMD values can also be expressed in several terms; for instance, DE in Mcal can be calculated by assuming 4.4 Mcal of DE per kg of TDN or DMD (Kromann et al. 1961, Rittenhouse et al. 1971); ME can be calculated by assuming 3.6 Mcal of ME per kg of TDN (NRC 1970).

Table 7.—*Average gross energy content of cattle diets*

Average sample date	Cage	Esophageal
	calories/gm	
April 20	4,403	4,036
May 21	4,300	4,003
June 27	4,310	4,016
July 27	4,130	3,892
August 29	4,108	4,146
September 28	4,171	3,871
November 3	3,996	3,850
December 12	3,947	3,932
January 27	4,041	4,002
February 27	3,988	4,049
Average	4,139	3,980

Table 8.—*Average crude protein in forage classes and cattle diets*

Average sample date	Forage			Diet	
	Grasses	Forbs	Woody	Cage	Esophageal
	percent				
April 20	14.1	20.0	14.8	13.4	17.8
May 21	11.0	16.3	12.9	9.7	12.4
June 27	9.3	12.9	10.6	8.7	12.2
July 27	8.2	12.2	9.9	8.2	10.3
August 29	8.5	12.8	10.3	8.6	11.2
September 28	7.3	11.4	9.6	7.1	9.0
November 3	6.1	9.3	8.6	5.8	9.7
December 12	4.7	7.0	7.7	5.2	7.9
January 27	4.5	6.2	7.6	5.1	9.7
February 27	5.7	13.6	7.6	5.5	11.0
Average	7.9	12.2	10.0	7.7	11.1

Crude Protein.—Crude protein content of forages was usually highest during spring (table 8). Animals selected a diet higher in crude protein than could be sampled by the caged-plot method. Examination of the data indicates that some of the forages were high enough in protein to enable the animals to select a higher quality diet than indicated by analysis of results from caged plots (appendix tables A2-4). Greatest differences in estimates of crude protein were observed during winter when animal-selected (esophageal samples) diets were more than 4.5 percentage points higher than samples from cages.

The minimum protein requirement for dry pregnant cows is about 5.9% and 9.2% for cows nursing calves (National Research Council 1970). The cattle were apparently able to select their minimum daily protein requirements from the native range except during De-

cember. However, on some ranges, cattle may be unable to select sufficient protein and additional supplementation would be necessary. For instance, if a diet similar to that from the caged plots were available, protein supplementation would be necessary from November through the winter, or until grass greens up in the spring.

Caged plot forages were also slightly protein deficient during summer for cows nursing calves. Protein values determined from the caged plots were similar to previous reports (Campbell et al. 1954). Most longleaf pine-bluestem range would be similar because of high grass yields resulting from burning. Consequently, protein supplementation may be necessary on longleaf pine-bluestem ranges from November until April and possibly during summer.

Phosphorus and Calcium.—Phosphorus content of forage throughout the year was inadequate to meet the NRC minimum cattle requirements of about 0.17% (table 9). Forbs and woody plants generally contained more phosphorus than grasses, but yearlong phosphorus supplements appear necessary on forest ranges. On the other hand, calcium was sufficient all year for meeting minimum daily NRC requirements of about 0.15% (table 10). Phosphorus, calcium, and total ash content in the esophageal samples were appreciably higher than in the caged-plot samples (tables 9–11); this difference was a result of saliva contaminants in the esophageal collections (Pearson 1974). Mineral analyses in esophageal samples are not reliable for determining deficiencies in forage.

Table 9.—*Average phosphorus content of forage classes and cattle diets*

Average sample date	Forage			Diet	
	Grasses	Forbs	Woody	Cage	Esophageal
	percent				
April 20	0.16	0.25	0.17	0.16	0.47
May 21	.12	.19	.18	.14	.32
June 27	.14	.12	.13	.08	.31
July 27	.09	.12	.11	.08	.27
August 29	.09	.12	.10	.10	.32
September 28	.08	.11	.10	.07	.29
November 3	.06	.10	.09	.05	.34
December 12	.04	.07	.08	.04	.30
January 27	.03	.05	.09	.03	.32
February 27	.05	.18	.09	.04	.32
Average	.09	.13	.11	.08	.33

To avoid phosphorus deficiencies in cattle grazing pine ranges, steamed bonemeal (10% phosphorus) should be provided free-choice. To prevent spoilage, two parts bonemeal can be mixed with one part salt (Halls et al. 1964), but salt should be provided separately even when the bonemeal-salt mixture is used.

Table 10.—*Average calcium content of forage classes and cattle diets*

Average sample date	Forage			Diet	
	Grasses	Forbs	Woody	Cage	Esophageal
	percent				
April 20	0.36	0.53	0.60	0.24	0.47
May 21	.25	.91	.73	.43	.50
June 27	.30	1.08	.95	.43	.55
July 27	.26	.90	.81	.48	.41
August 29	.25	1.24	.92	.42	.43
September 28	.26	1.20	1.07	.46	.72
November 3	.27	.83	1.00	.47	.76
December 12	.26	.99	.88	.38	.62
January 27	.18	1.05	.98	.31	.73
February 27	.19	.82	.88	.29	.64
Average	.26	.96	.88	.39	.58

Table 11.—*Average ash content of forage classes and cattle diets*

Average sample date	Forage			Diet	
	Grasses	Forbs	Woody	Cage	Esophageal
	percent				
April 20	7.5	10.2	4.4	6.1	12.2
May 21	8.6	10.0	5.0	7.1	12.0
June 27	8.7	8.3	5.2	6.3	13.4
July 27	8.9	10.3	5.4	8.1	12.6
August 29	8.6	10.1	5.1	7.1	10.9
September 28	7.8	9.9	5.2	7.9	12.0
November 3	7.4	8.8	4.7	8.0	12.4
December 12	7.1	10.6	4.9	11.5	12.6
January 27	7.8	14.2	4.5	7.5	12.4
February 27	8.0	14.0	4.1	9.5	14.0
Average	8.1	10.6	4.8	7.9	12.5

Vitamin A.—Cattle requirements for vitamin A (carotene) are about 2,500–5,000 IU/kg of feed (National Research Council 1970). Apparently the minimum requirements are available yearlong, as indicated by cattle diets (esophageal fistulated animals), but monthly variations are not explainable from the data (table 12).

Forage Use and Cattle Diets

Herbage production averaged 688 kg/ha (614 lb/acre) and varied from 580–868 kg/ha (518–775 lb/acre) during the three years of sampling (table 13). Grasses made up more than 80% of the total botanical composition. Utilization averaged 66%. Pinehill bluestem provided the greatest yields; panicums, other grasses, and forbs, including composites and legumes, each yielded 11–15% of the total herbage.

Diet composition based on caged plots varied according to herbage composition and indicated little selec-

tivity. No use or production of woody plants was recorded under the cages, even though esophageal samples showed use of woody plants, suggesting selective grazing during some periods of the year (appendix table A5). For instance, shrubs were most prevalent in winter diets. Pine needles found in esophageal samples were probably consumed inadvertently while the cattle were grazing low forages (Pearson 1976).

There are several problems with measuring vegetation to determine consumption. Wildlife can also remove vegetation and losses can occur from such sources as weathering and trampling. Some utilization may go undetected when plants are pulled up by the roots, plant parts are pulled off leaving no visible signs, or use is obscured by subsequent growth. Analyses of actual diet samples are superior to vegetation measurements for determining which plants animals eat, especially if evaluations are to include nutritional values or minor species in the diet. However, for practical purposes of stocking the range, vegetation measurements provide the most reliable guide. A combination of direct animal and vegetation measurements will give the best description of all plant and animal ecology on the range, the effects of grazing, and management alternatives for livestock, wildlife, and forage.

Table 12.—*Average vitamin A (carotene) content of cattle diets*

Average sample date	Vitamin A content	
	Cage	Esophageal
	IU/kg × 1000	
April 20	7.6	16.5
May 21	11.7	7.4
June 27	1.5	7.6
July 27	3.1	6.4
August 29	1.8	20.3
September 28	4.3	8.3
November 3	([1])	12.2
December 12	1.3	3.8
January 27	0.9	4.2
February 27	5.2	8.0
Average	4.2	9.5

[1]Missing data.

CONCLUSIONS AND RECOMMENDATIONS

Forage plants growing on southern pine ranges vary in nutritional value throughout the year. Grasses, mainly the bluestems, are the most prevalent forage in the cattle diet. Forbs and woody plants add variety to the diet and are especially important during fall and winter when grasses become dormant. The range manager needs to be able to recognize important forage plants and their abundance if forage value and livestock needs are to be determined.

Table 13.—*Botanical composition of cattle diet and forage yield as determined from caged plots, 1971–74*

Species	Diet	Yield	Diet	Yield
	percent		*kg/ha*	
Grasses and grasslikes:				
Pinehill bluestem	42	42	193	295
Slender bluestem	8	9	37	53
Big bluestem	T[1]	T	1	1
Other bluestems	2	1	7	9
Paspalums	1	1	5	6
Panicums	11	13	48	84
Cutover muhly	3	3	13	24
Silkyscale	4	3	15	17
Other grasses	12	13	54	93
Grasslikes	T	T	1	2
Total	83	85	375	589
Forbs:				
Swamp sunflower	8	6	32	37
Other composites	3	4	14	27
Tephrosia	T	1	2	5
Other legumes	1	1	6	8
Other forbs	5	3	20	23
Total	17	15	74	99
Grand Total	100	100	449	688

[1]T = less than 0.5.

Forage digestibility and nutritive values are highest in spring when forages are growing rapidly. Values are lowest during winter when most of the plant growth is at a minimum. Crude protein content of grasses was below the amounts required for cattle from November until spring greenup in March and April. However, some deficiencies were alleviated through the animals' selectivity (they chose plants higher in crude protein during winter). Phosphorus was deficient yearlong, while calcium and vitamin A were adequate throughout the year. Animal growth and maintenance are governed by the amount of digestible energy consumed when other nutrients such as protein and phosphorus are adequate. Digestible energy in the cattle diet exceeded daily requirements except during November through February. Appendix tables A2–4 give the forage digestibility, crude protein, ether extract, crude fiber, nitrogen-free extract, calcium, phosphorus, and vitamin A content of 32 forest range species at different stages of growth throughout the year.

General recommendations for making up the yearly estimated deficiencies with protein, energy, and mineral supplements include: (a) 150–181 kg (330–400 lb) cottonseed cake or meal, hand fed from November until spring greenup (see table 1 for recommended schedule); (b) 163 kg (360 lb) grass-legume hay fed from mid-December until mid-March; (c) 8 kg (17 lb) steamed bonemeal fed free choice yearlong; and (d) 9 kg (20 lb) salt, fed free choice yearlong.

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Appendix

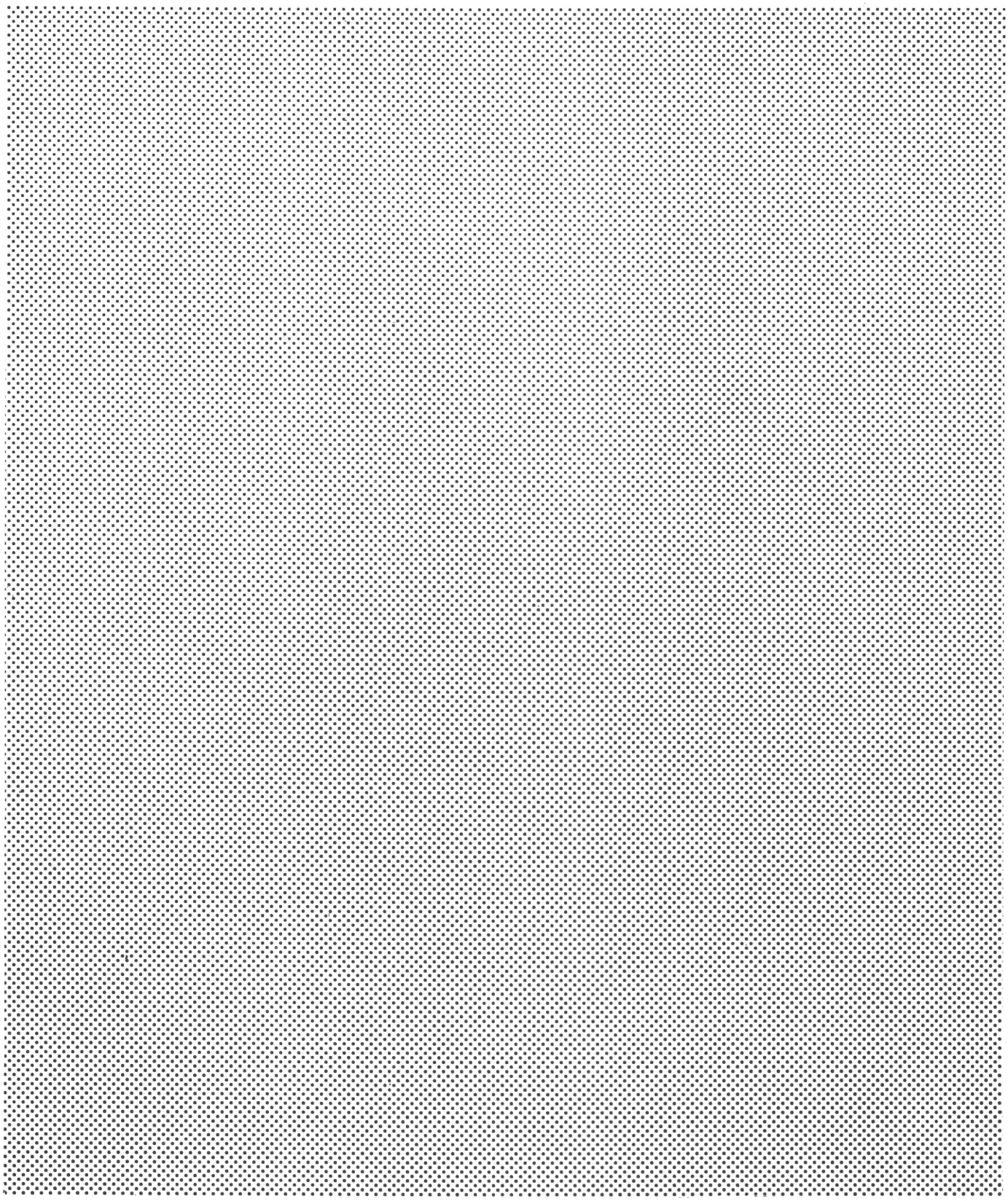

Table A-1.—*Scientific and common names of selected plants on the Palustris Experimental Forest*

Scientific name	Common name
Grasses:	
Andropogon scoparius var. *divergens* Anderss. ex Hack.	pinehill bluestem
Andropogon gerardii Vitman	big bluestem
Andropogon tener (Nees) Kunth	slender bluestem
Andropogon ternarius Michx.	paintbrush bluestem
Andropogon virginicus L.	broomsedge bluestem
Anthaenantia villosa (Michx.) Beauv.	green silkyscale
Aristida purpurascens Poir.	arrowfeather threeawn
Axonopus affinis Chase	common carpetgrass
Eragrostis spectabilis (Pursh) Steud.	purple lovegrass
Gymnopogon ambiguus (Michx.) BSP.	bearded skeletongrass
Manisuris cylindrica (Michx.) Kuntze	Carolina jointtail
Mulhenbergia expansa (DC.) Trin.	cutover muhly
Panicum aciculare Desv. ex Poir.	needleleaf panicum
Panicum anceps Michx.	spreading panicum
Panicum angustifolium Ell.	narrowleaf panicum
Panicum brachyanthum Steud.	pimple panicum
Panicum lanuginosum Ell.	woolly panicum
Panicum sphaerocarpon Ell.	roundseed panicum
Panicum virgatum L	switchgrass
Paspalum bifidum (Bertol.) Nash	pitchfork paspalum
Paspalum floridanum Michx.	Florida paspalum
Paspalum plicatulum Michx.	brownseed paspalum
Paspalum setaceum var. *ciliatifolium* (Michx.) Vasey	fringeleaf paspalum
Paspalum setaceum var. *muhlenbergii* (Nash) Banks	hurrahgrass
Sporobolus junceus (Michx.) Kunth	pineywoods dropseed
Tridens flavus (L.) Hitchc.	purpletop tridens
Uniola laxa (L.) BSP.	spike uniola
Uniola sessiliflora Poir.	longleaf uniola
Forbs	
Desmodium ciliare (Muhl.) DC.	littleleaf tickclover
Diodia teres Walt.	poor-joe
Helianthus angustifolius L.	swamp sunflower
Hymenopappus artemisiaefolius DC.	ragweed woollywhite
Pteridium aquilinum var. *pseudocaudatum* (Clute) Heller	southern bracken
Rhynchosia difformis (Ell.) DC.	hairy rhynchosia
Silphium gracile Gray	slender rosinweed
Stylosanthes biflora (L.) BSP.	pencilflower
Tephrosia onobrychoides Nutt.	weak tephrosia
Tephrosia virginiana (L.) Pers.	Virginia tephrosia
Woody plants:	
Callicarpa americana L.	American beautyberry
Cornus florida L	flowering dogwood
Lonicera japonica Thunb.	Japanese honeysuckle
Myrica cerifera L.	southern waxmyrtle
Pinus palustris Mill.	longleaf pine
Pinus taeda L.	loblolly pine
Quercus spp.	oaks
Rhus copallina L.	shining sumac
Rubus spp.	blackberry
Sassafras albidum (Nutt.) Nees	sassafras
Smilax rotundifolia L.	common greenbriar
Vaccinium elliottii Chapm.	Elliott blueberry
Vitis aestivalis Michx.	summer grape

Table A-2.—*Nutritional composition and in vitro dry matter digestibility (IVDMD) of selected grasses during different stages of phenological development, Palustris Experimental Forest*

Average sample date/ species[1]	Stage of development[2]	IVDMD	Crude protein	Ether extract	Crude fiber	Nitrogen-free extract	Ash	Calcium	Phosphorus	Vitamin A
		percent								*(IU/kg × 100)*
April 20										
Big bluestem	young leaf	54.7	13.49	2.41	31.36	46.71	6.03	.80	.15	120.61
Pinehill bluestem	young leaf	52.6	11.59	1.93	33.15	47.97	5.36	.27	.12	101.93
Slender bluestem	young leaf	60.5	13.93	6.54	30.12	40.41	9.00	.32	.18	50.38
Broomsedge bluestem	young leaf	37.9	9.74	2.03	30.73	44.59	4.50	.18	.12	34.26
Green silkyscale	young leaf	68.6	19.12	3.01	25.13	42.00	10.74	.20	.24	322.23
Common carpetgrass	young leaf	55.0	11.87	1.96	25.16	54.26	6.75	.25	.14	68.63
Purple lovegrass[3]	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Cutover muhly	young leaf	47.3	14.21	1.61	34.66	42.74	6.78	.20	.18	16.15
Narrowleaf panicum	early seed	56.2	16.15	5.38	30.79	39.50	8.18	.18	.14	152.85
Needleleaf panicum	early seed	50.0	13.44	2.58	29.68	44.73	9.57	.15	.10	83.87
Woolly panicum	early seed	51.8	12.26	1.61	31.40	45.48	9.25	.90	.10	102.15
Switchgrass	young leaf	50.1	17.40	3.44	29.65	44.03	5.48	.41	.27	287.86
Florida paspalum	young leaf	52.5	16.18	4.23	29.21	41.80	8.58	.45	.20	154.18
May 21										
Big bluestem	young leaf	42.5	11.15	2.56	33.58	46.62	6.09	.23	.11	263.42
Pinehill bluestem	young leaf	40.7	10.31	2.23	33.37	47.85	6.24	.29	.12	304.79
Slender bluestem	young leaf	45.6	10.84	2.20	33.68	44.30	8.98	.40	.14	100.38
Broomsedge bluestem	young leaf	33.0	8.61	2.80	32.08	52.19	4.32	.20	.12	247.07
Green silkyscale	young leaf	62.1	16.42	4.34	28.31	37.23	13.70	.18	.18	471.67
Common carpetgrass	full leaf/ early seed	46.5	10.56	2.61	27.45	51.05	8.33	.28	.14	395.39
Purple lovegrass	young leaf	50.3	8.35	2.39	35.14	47.29	6.83	.21	.10	105.21
Cutover muhly	young leaf	34.6	9.72	1.79	38.12	42.96	7.41	.21	.12	139.53
Narrowleaf panicum	full leaf/seed disseminating	46.0	9.79	2.54	33.93	44.78	8.96	.20	.08	160.99
Needleleaf panicum	full leaf/seed disseminating	46.2	11.64	2.96	32.80	41.50	11.10	.19	.10	248.72
Woolly panicum	full leaf/seed disseminating	46.5	11.12	3.39	30.52	42.41	12.56	.21	.08	257.44
Switchgrass	young leaf	46.4	13.39	3.68	32.05	44.95	5.93	.28	.17	559.31
Florida paspalum	young leaf	40.5	10.41	2.82	32.53	42.66	11.58	.39	.16	275.39
June 27										
Big bluestem	full leaf	41.0	9.32	3.32	35.48	45.66	6.22	.43	.10	85.38
Pinehill bluestem	full leaf	34.4	8.10	2.12	37.28	45.98	6.52	.32	.08	20.70
Slender bluestem	full leaf/boot	42.4	8.12	3.49	37.90	42.25	8.24	.37	.10	20.86
Broomsedge bluestem	full leaf	21.2	7.86	2.40	34.27	50.17	5.30	.18	.11	20.86
Green silkyscale	full leaf	50.9	13.65	3.51	30.92	42.27	9.65	.25	.12	24.18
Common carpetgrass	full leaf/seed ripening	44.6	10.22	2.78	28.81	48.85	9.34	.29	.14	14.30
Purple lovegrass[3]	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Cutover muhly	full leaf	26.8	7.99	2.34	39.97	42.36	7.34	.24	.09	20.72
Narrowleaf panicum	full leaf/seed disseminating	38.1	8.11	4.03	34.14	44.58	9.14	.27	.35	19.59
Needleaf panicum	full leaf/seed disseminating	27.6	9.08	4.24	32.23	41.02	13.43	.18	.07	10.83
Woolly panicum	full leaf/seed disseminating	36.8	8.04	3.86	34.08	45.28	8.74	.25	.20	15.79
Switchgrass	full leaf	36.2	11.10	2.56	34.42	46.11	5.81	.37	.14	35.13
Florida paspalum	full leaf	36.5	9.62	2.27	32.61	41.22	14.28	.42	.12	17.30
July 27										
Big bluestem	full leaf	38.1	8.83	2.85	36.75	44.65	6.92	.22	.09	61.67
Pinehill bluestem	full leaf	30.6	7.50	1.59	36.97	47.99	5.95	.35	.09	53.26
Slender bluestem	full leaf/early seed	37.8	7.91	2.50	35.37	45.34	8.88	.31	.09	45.90
Broomsedge bluestem	full leaf/boot	26.3	7.50	2.42	35.14	49.67	5.27	.20	.07	42.94
Green silkyscale	full leaf/boot	49.0	11.48	3.02	31.38	42.89	11.23	.19	.10	141.59
Common carpetgrass	full leaf/seed disseminating	44.3	8.87	2.79	34.04	46.55	7.75	.23	.15	92.14

Table A-2.—*Nutritional composition and in vitro dry matter digestibility (IVDMD) of selected grasses during different stages of phenological development, Palustris Experimental Forest—Continued*

Average sample date/ species[1]	Stage of development[2]	IVDMD	Crude protein	Ether extract	Crude fiber	Nitrogen-free extract	Ash	Calcium	Phosphorus	Vitamin A
		percent								*(IU/kg × 100)*
Purple lovegrass	full leaf/boot	41.9	7.42	1.51	37.96	44.72	8.39	.26	.09	[4]
Cutover muhly	full leaf/boot	22.2	6.21	1.76	40.04	46.50	5.49	.18	.06	40.12
Narrowleaf panicum	full leaf/seed disseminating	37.5	8.07	3.68	30.13	43.92	14.20	.21	.06	35.34
Needleleaf panicum	mature leaf/seed disseminating	35.1	7.75	3.78	31.79	45.22	11.46	.16	.07	48.44
Woolly panicum	mature leaf/seed disseminating	41.6	8.76	3.90	31.16	44.20	11.98	.25	.07	100.49
Switchgrass	full leaf/boot	39.2	8.43	2.37	34.35	48.36	6.49	.38	.11	68.46
Florida paspalum	full leaf/boot	39.5	7.48	1.91	35.37	43.90	11.34	.39	.08	59.15
August 29										
Big bluestem	full leaf/boot	35.0	8.03	3.79	36.64	44.81	6.73	.34	.08	87.45
Pinehill bluestem	full leaf/boot	30.0	7.48	1.94	38.18	46.48	5.92	.28	.09	56.52
Slender bluestem	full leaf/early seed	29.8	7.38	1.90	34.80	47.03	8.89	.27	.08	18.44
Broomsedge bluestem	full leaf/boot	25.9	7.72	2.54	34.65	49.37	5.72	.19	.11	59.41
Green silkyscale	full leaf/heads out	48.4	11.76	2.38	38.98	38.92	7.96	.16	.12	56.80
Common carpetgrass	full leaf/seed disseminating	38.2	8.72	1.78	34.14	47.50	7.86	.22	.14	25.84
Purple lovegrass	full leaf	[4]	8.30	2.23	37.34	40.96	11.17	.27	.09	33.19
Cutover muhly	full leaf/heads out	22.5	7.55	1.68	37.70	45.68	7.39	.22	.10	56.38
Narrowleaf panicum	mature leaf/seed disseminating	38.5	8.86	4.83	31.99	43.32	11.00	.22	.07	129.94
Needleaf panicum	mature leaf/seed disseminating	34.1	8.68	5.30	29.48	44.67	11.87	.16	.07	51.55
Woolly panicum	mature leaf/seed disseminating	39.6	9.42	3.22	29.79	47.21	10.36	.28	.06	125.25
Switchgrass	full leaf/early seed	30.0	8.75	2.43	33.48	48.10	7.24	.37	.10	64.24
Florida paspalum	full leaf/early seed	33.0	8.04	4.55	33.60	42.39	11.42	.30	.10	186.12
September 28										
Big bluestem	full leaf/seed ripening	32.3	7.43	1.82	31.47	52.70	6.58	.34	.08	123.52
Pinehill bluestem	full leaf/early seed	28.2	5.53	1.58	37.68	49.43	5.78	.29	.05	113.41
Slender bluestem	full leaf/seed ripening	27.5	5.46	2.14	36.36	48.41	7.63	.25	.05	58.23
Broomsedge bluestem	full leaf/seed disseminating	24.1	5.49	1.76	37.08	50.86	4.81	.16	.12	54.37
Green silkyscale	full leaf/seed ripening	38.8	9.54	2.46	35.86	44.47	7.67	.16	.09	297.17
Common carpetgrass	full leaf/seed disseminating	40.6	10.62	1.70	30.66	49.51	7.51	.26	.17	52.52
Purple lovegrass	full leaf	27.6	6.58	1.62	36.46	47.68	7.66	.22	.06	15.20
Cutover muhly	full leaf/seed ripening	17.2	5.66	1.47	38.26	50.21	4.40	.18	.05	27.38
Narrowleaf panicum	mature leaf/seed disseminating	31.8	8.63	3.41	28.60	47.26	12.10	.27	.06	173.94
Needleaf panicum	mature leaf/seed disseminating	29.1	7.99	3.94	29.09	45.24	13.74	.18	.05	160.02
Woolly panicum	mature leaf/seed disseminating	28.3	7.64	3.52	31.42	46.80	10.62	.26	.05	259.33
Switchgrass	mature leaf/seed disseminating	29.4	8.03	1.86	32.70	51.39	6.02	.54	.10	96.81
Florida paspalum	full leaf)/seed ripening	34.6	6.00	3.39	40.34	44.35	5.92	.33	.06	63.47

Table A-2.—*Nutritional composition and in vitro dry matter digestibility (IVDMD) of selected grasses during different stages of phenological development, Palustris Experimental Forest—Continued*

Average sample date/ species[1]	Stage of development[2]	IVDMD	Crude protein	Ether extract	Crude fiber	Nitrogen-free extract	Ash	Calcium	Phosphorus	Vitamin A
					percent					*(IU/kg × 100)*
November 3										
Big bluestem	mature leaf/seed disseminating	27.0	5.37	1.50	33.19	51.13	8.81	.34	.05	[4]
Pinehill bluestem	mature leaf/seed disseminating	16.4	4.50	1.07	39.76	49.26	5.41	.32	.03	[4]
Slender bluestem	mature leaf	24.9	5.21	1.19	34.92	48.59	10.09	.29	.04	[4]
Broomsedge bluestem	mature leaf/seed disseminating	19.7	5.69	2.69	36.63	51.66	3.33	.12	.12	[4]
Green silkyscale	mature leaf/seed disseminating	37.2	4.42	1.62	39.12	47.62	7.22	.20	.03	[4]
Common carpetgrass	full leaf/seed disseminating	40.0	9.72	1.51	30.02	51.84	6.91	.25	.12	[4]
Purple lovegrass	mature leaf	21.4	4.94	1.50	38.63	49.35	5.58	.25	.03	[4]
Cutover muhly	mature leaf/seed disseminating	13.9	5.05	.86	38.35	50.69	5.05	.14	.05	[4]
Narrowleaf panicum	mature leaf/seed disseminating	32.8	8.06	4.19	27.82	49.94	9.99	.31	.04	[4]
Needleaf panicum	mature leaf/seed disseminating	20.8	6.39	3.14	30.30	50.00	10.17	.18	.05	[4]
Woolly panicum	mature leaf/seed disseminating	24.5	6.34	4.83	30.93	47.70	10.20	.23	.05	[4]
Switchgrass	mature leaf/seed disseminating	26.4	7.93	1.82	29.80	54.13	6.32	.65	.08	[4]
Florida paspalum[3]	...	...	...	...	...	...	...	...	...	...
December 12										
Big bluestem	dormant	17.0	3.84	2.08	37.51	49.40	7.17	.27	.03	21.46
Pinehill bluestem	dormant	16.5	3.88	1.64	39.52	48.32	6.64	.26	.03	19.95
Slender bluestem	dormant	15.0	3.32	3.52	39.65	46.94	6.57	.21	.03	30.89
Broomsedge bluestem	dormant	10.4	4.10	1.66	37.68	52.05	4.51	.18	.04	17.19
Green silkyscale	dormant	23.0	3.49	1.63	42.78	46.42	5.68	.20	.02	20.58
Common carpetgrass	dormant	24.4	7.64	1.38	31.56	52.01	7.41	.29	.09	58.09
Purple lovegrass	dormant	25.0	5.57	1.90	36.94	48.50	7.09	.30	.05	19.64
Cutover muhly	dormant	11.9	4.46	1.42	38.38	50.83	4.91	.19	.04	17.76
Narrowleaf panicum	dormant	16.6	5.43	3.09	29.00	53.22	9.26	.28	.03	26.67
Needleleaf panicum	dormant	13.5	5.29	3.09	30.70	48.99	11.93	.21	.03	18.91
Woolly panicum	dormant	18.7	5.35	4.43	31.79	47.48	10.95	.21	.04	21.16
Switchgrass	dormant	21.0	4.23	1.69	39.21	50.20	4.67	.44	.03	21.09
Florida paspalum	dormant	7.1	4.52	1.51	40.58	47.79	5.60	.46	.03	10.76
January 27										
Big bluestem	dormant	11.4	3.64	1.61	42.23	47.27	5.25	.17	.03	9.65
Pinehill bluestem	dormant	18.2	3.75	1.39	37.19	50.81	6.86	.19	.02	12.86
Slender bluestem	dormant	15.6	3.90	1.19	39.26	48.49	7.16	.11	.07	6.51
Broomsedge bluestem	dormant	11.3	3.86	1.29	37.12	52.47	5.26	.13	.03	12.88
Green silkyscale	dormant	17.4	2.80	1.18	39.61	46.83	9.58	.19	.01	12.92
Common carpetgrass	dormant	26.0	8.23	1.52	30.44	51.90	7.91	.27	.09	43.34
Purple lovegrass[3]	...	...	...	...	...	...	...	...	...	...
Cutover muhly	dormant	10.6	4.07	1.61	37.62	52.20	4.50	.09	.02	16.08
Narrowleaf panicum	dormant	15.0	5.15	4.08	32.08	47.10	11.59	.14	.03	26.82
Needleleaf panicum	dormant	14.7	6.23	2.90	31.69	47.79	11.39	.14	.03	30.08
Woolly panicum	dormant	16.4	5.03	3.53	32.98	44.97	13.49	.13	.03	29.98
Switchgrass	dormant	12.0	4.08	1.83	39.74	50.05	4.30	.28	.02	12.89
Florida paspalum	dormant	16.4	3.56	1.83	40.57	48.01	5.93	.31	.01	19.42
February 27										
Big bluestem	dormant	20.9	5.48	1.61	36.01	49.08	7.82	.25	.06	138.54
Pinehill bluestem	dormant	14.1	3.84	1.26	38.91	50.15	5.84	.22	.02	48.18
Slender bluestem	dormant	13.9	3.57	1.18	38.58	47.67	9.00	.16	.02	8.64
Broomsedge bluestem	dormant	9.8	4.18	1.40	36.64	53.34	4.44	.14	.04	50.81
Green silkyscale	dormant	16.0	2.84	1.28	48.33	44.54	3.01	.13	.01	5.92
Common carpetgrass	dormant	24.0	8.56	1.33	27.93	53.28	8.90	.24	.08	144.00

Table A-2.—*Nutritional composition and in vitro dry matter digestibility (IVDMD) of selected grasses during different stages of phenological development, Palustris Experimental Forest—Continued*

Average sample date/ species[1]	Stage of development[2]	IVDMD	Crude protein	Ether extract	Crude fiber	Nitrogen-free extract	Ash	Calcium	Phosphorus	Vitamin A
		percent								*(IU/kg × 100)*
Purple lovegrass	dormant	19.3	4.09	1.70	37.91	50.24	6.06	.22	.03	10.76
Cutover muhly	dormant	8.9	3.59	1.32	37.66	52.09	5.34	.11	.02	26.97
Narrowleaf panicum	young leaf	33.4	9.41	2.53	26.95	46.67	14.44	.19	.07	504.30
Needleleaf panicum	young leaf	25.6	7.34	2.81	29.28	45.39	15.18	.15	.05	291.85
Woolly panicum	young leaf	26.3	9.05	2.38	31.52	45.07	11.98	.19	.07	261.32
Switchgrass	dormant	9.5	3.67	1.67	39.66	50.58	4.42	.29	.02	22.08
Florida paspalum	dormant	11.6	3.39	.95	37.46	50.48	7.72	.24	.02	50.79

[1]Scientific nomenclature given in appendix table A-1.

[2]Stages of development:
rosette—a cluster of basal leaves appearing radially arranged.
young or early leaf—early leaf growth, usually during spring on deciduous plants.
new leaf or early needle—early growth of new leaves or needles on evergreen plants.
full leaf—leaves fully grown with maximum physiological activity.
full needle—needles fully grown with maximum physiological activity.
mature leaf—leaves fully grown with cessation of physiological activity, usually during the fall.
color—the color change in the mature leaves of deciduous plants prior to the annual leaf fall.
no leaves—twigs or branches of deciduous plants following the annual leaf fall.
dormant—no growth occurring; plants mature or dry.
buds—leaf or flower buds showing; early development of leaf or flower.
flowering—having flowers; in bloom.
flowerstalk—the main stem of a plant on which the flower grows or is supported.
boot—early floral development in grasses; inflorescence or flower parts enclosed in the sheath near the uppermost leaves on the stems of grasses.
heads out—floral development in grasses; inflorescence out of the sheath but prior to anthesis.
fruit—seed bearing part of a plant.
early seed—early seed development; soon after anthesis (full bloom in flowers) but prior to the dough stage.
seed ripening—seed developing but not fully mature.
fruit ripe—fruit mature and fully developed but persistent on the plant.
seed disseminating, fruit dropping, or seedfall—seed or fruit fully developed, mature and disseminating from the plant.

[3]Plant not collected.

[4]Missing data.

Table A-3.—*Nutritional composition and in vitro dry matter digestibility (IVDMD) of selected forbs during different stages of phenological development, Palustris Experimental Forest*

Average sample date/ species[1]	Stage of development[2]	IVDMD	Crude protein	Ether extract	Crude fiber	Nitrogen-free extract	Ash	Calcium	Phosphorus	Vitamin A
		percent								*(IU/kg × 100)*
April 20										
Littleaf tickclover	early leaf	35.2	22.21	2.34	22.95	45.80	6.70	.71	.26	116.90
Swamp sunflower	early leaf	45.6	17.85	2.96	12.71	45.89	20.59	.92	.19	69.00
Ragweed woollywhite	full leaf	47.8	14.83	4.38	25.40	48.13	7.26	.31	.21	117.40
Southern bracken	early leaf	25.4	19.51	2.77	18.34	51.92	7.46	.13	.23	83.16
Slender rosinweed	early leaf	47.2	18.89	4.48	11.24	47.92	17.47	.94	.23	103.71
Pencilflower[3]	...	...	...	...	...	...	...	...	...	...
Weak tephrosia	early leaf	46.6	22.86	2.33	29.74	37.24	7.83	.42	.29	250.79
Virginia tephrosia	early leaf	48.7	23.76	5.60	26.93	39.38	4.33	.26	.33	138.33
May 21										
Littleleaf tickclover	full leaf/ flowerstalk	26.4	17.30	2.43	30.46	43.22	6.59	1.08	.17	528.92
Swamp sunflower	early leaf	38.2	15.36	4.14	13.97	45.23	21.30	1.17	.15	160.38
Ragweed woollywhite	full leaf/ flowering	36.6	12.61	4.36	31.02	43.17	8.84	.62	.19	171.36
Southern bracken	full leaf	26.7	18.27	2.49	27.65	45.09	6.50	.22	.24	253.66
Slender rosinweed	early leaf/ flowering	49.1	12.36	6.46	21.17	50.62	9.39	1.38	.18	235.53
Pencilflower	full leaf/ flowering	53.5	15.99	2.21	26.99	40.60	14.21	1.73	.15	176.48
Weak tephrosia	full leaf/ flowering	37.5	18.18	3.18	32.53	38.20	7.91	.56	.20	164.62
Virginia tephrosia	full leaf/ flowering	34.1	18.11	4.24	27.67	45.78	4.20	.36	.20	544.09
June 27										
Littleleaf tickclover	full leaf/seed ripening	29.4	14.22	2.82	26.77	50.39	5.80	1.15	.11	66.98
Swamp sunflower	full leaf/ flowerstalk	46.3	13.45	5.78	16.58	48.89	15.30	1.39	.14	32.49
Ragweed woollywhite	dormant/seed disseminating	22.5	6.98	2.66	38.36	44.13	7.87	.92	.07	21.06
Southern bracken	full leaf	9.2	10.78	2.33	28.67	50.72	7.50	.32	.12	31.15
Slender rosinweed	full leaf/seed ripening	48.3	10.51	6.34	31.73	41.25	10.17	1.68	.18	21.09
Pencilflower	full leaf/ flowering	54.8	12.98	2.87	29.38	43.39	11.38	1.81	.10	17.68
Weak tephrosia	full leaf/seed ripening	34.0	15.52	3.00	37.96	39.54	3.98	.81	.12	19.08
Virginia tephrosia	full leaf/seed ripening	29.8	15.20	5.55	32.38	42.13	4.74	.55	.12	454.74
July 27										
Littleleaf tickclover	full leaf/seed ripening	26.1	14.78	3.00	35.01	39.86	7.35	.93	.11	208.72
Swamp sunflower	full leaf/ flowerstalk	45.3	11.31	4.32	15.25	44.36	24.76	1.21	.12	57.42
Ragweed woollywhite	dormant/seed disseminatig	29.6	9.48	4.30	34.84	43.13	8.25	.90	.10	23.24
Southern bracken	full leaf	16.7	12.67	1.77	32.08	48.58	4.90	.27	.13	90.95
Slender rosinweed	dormant/seed disseminating	35.9	8.90	5.47	28.95	44.22	12.46	1.44	.12	34.97
Pencilflower	full leaf/seed ripening	50.7	12.50	2.57	31.98	40.82	12.13	1.11	.11	67.22
Weak tephrosia	full leaf/seed ripening	32.0	11.84	3.25	40.82	37.82	6.27	.75	.11	69.63
Virginia tephrosia	full leaf/seed ripening	27.9	14.70	5.25	33.50	41.44	5.11	.73	.12	389.76

Table A-3.—*Nutritional composition and in vitro dry matter digestibility (IVDMD) of selected forbs during different stages of phenological development, Palustris Experimental Forest—Continued*

Average sample date/ species[1]	Stage of development[2]	IVDMD	Crude protein	Ether extract	Crude fiber	Nitrogen-free extract	Ash	Calcium	Phosphorus	Vitamin A
		percent								(IU/kg × 100)
August 29										
Littleleaf tickclover	full leaf/seed ripening	29.4	16.34	3.55	29.62	42.52	7.97	1.40	.13	192.02
Swamp sunflower	full leaf/ flowering	44.3	13.26	6.60	19.80	48.28	12.06	1.30	.16	82.64
Ragweed woollywhite	dormant	42.8	11.71	3.76	20.66	52.49	11.38	.91	.12	138.12
Southern bracken	full leaf	12.6	8.98	1.38	29.34	51.31	8.99	.48	.10	113.72
Slender rosinweed	dormant/seed disseminating	40.6	9.34	5.66	19.84	50.72	14.44	2.74	.10	154.18
Pencilflower	full leaf/seed disseminating	48.6	13.11	1.73	29.19	40.19	15.78	1.44	.17	61.72
Weak tephrosia	full leaf/seed ripening	28.3	19.97	3.54	42.38	25.33	8.78	.90	.12	78.57
Virginia tephrosia	full leaf/seed ripening	29.8	16.01	5.39	35.51	36.73	6.36	.66	.12	383.84
September 28										
Littleleaf tickclover	full leaf/seed disseminating	26.6	12.29	2.53	39.76	38.76	6.66	1.46	.10	177.87
Swamp sunflower	full leaf/ flowering	40.8	11.08	6.08	31.28	42.92	8.64	1.02	.17	64.94
Ragweed woollywhite	dormant	37.0	11.60	5.13	17.69	52.26	13.32	.98	.12	49.70
Southern bracken	dormant	17.3	12.21	1.86	30.92	48.21	6.80	.39	.12	152.60
Slender rosinweed	dormant/seed disseminating	40.2	9.27	5.49	21.50	48.08	15.66	1.94	.11	73.42
Pencilflower	full leaf/seed disseminating	45.2	12.16	2.20	28.19	39.90	17.55	1.74	.10	86.25
Weak tephrosia	full leaf/seed disseminating	26.5	10.38	2.32	42.38	36.85	8.07	1.03	.07	63.98
Virginia tephrosia	full leaf/seed disseminating	24.7	12.57	5.27	35.51	41.76	4.89	.85	.09	374.25
November 3										
Littleleaf tickclover[3]	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Swamp sunflower	full leaf/seed ripening	39.5	8.61	3.27	29.85	48.14	10.13	1.08	.12	[4]
Ragweed woollywhite	winter rosette	48.0	13.80	5.48	17.74	50.93	12.05	1.10	.15	[4]
Southern bracken	dormant	3.1	4.87	1.11	36.39	49.44	8.19	.40	.06	[4]
Slender rosinweed[3]	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Pencilflower[3]	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Weak tephrosia[3]	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Virginia tephrosia	dormant	21.0	9.80	3.66	40.04	41.76	4.74	.75	.05	[4]
December 12										
Littleleaf tickclover	dormant/seed disseminating	19.0	5.93	1.57	58.39	30.20	3.91	1.02	.04	32.44
Swamp sunflower	dormant/seed disseminating	20.9	4.48	3.55	43.96	39.65	8.36	.96	.04	10.72
Ragweed woollywhite	winter rosette	43.8	11.73	5.44	19.88	45.72	17.23	1.04	.14	125.64
Southern bracken	dormant	8.2	6.44	1.12	41.30	43.31	7.83	.39	.06	17.16
Slender rosinweed	dormant	30.4	7.78	4.70	24.76	39.76	23.00	1.73	.09	79.77
Pencilflower[3]	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Weak tephrosia[3]	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Virginia tephrosia	dormant	19.2	8.04	3.46	50.02	34.06	4.42	.84	.05	110.94
January 27										
Littleleaf tickclover[3]	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Swamp sunflower	dormant	12.9	3.91	2.28	50.33	36.85	6.63	.70	.02	9.78
Ragweed woollywhite[3]	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Southern bracken[3]	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Slender rosinweed	winter rosette	31.1	8.40	4.14	22.14	43.51	21.81	1.41	.09	52.34
Pencilflower[3]	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Weak tephrosia[3]	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Virginia tephrosia[3]	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .

Table A-3.—*Nutritional composition and in vitro dry matter digestibility (IVDMD) of selected forbs during different stages of phenological development, Palustris Experimental Forest—Continued*

Average sample date/ species[1]	Stage of development[2]	IVDMD	Crude protein	Ether extract	Crude fiber	Nitrogen-free extract	Ash	Calcium	Phosphorus	Vitamin A
		percent								*(IU/kg × 100)*
February 27										
Littleleaf tickclover[3]	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Swamp sunflower	dormant/early leaf	22.0	7.60	2.41	40.45	37.72	11.82	.71	.07	495.08
Ragweed woollywhite	winter rosette	49.7	17.29	5.05	15.44	45.64	16.58	1.11	.24	150.78
Southern bracken	dormant	4.8	5.44	.92	41.60	45.61	6.43	.33	.06	20.90
Slender rosinweed	winter rosette	48.2	25.36	5.25	10.72	39.05	19.62	.98	.36	479.42
Pencilflower[3]	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Weak tephrosia[3]	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Virginia tephrosia[3]	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .

[1]Scientific nomenclature given in appendix table A-1.
[2]Stages of development:
rosette—a cluster of basal leaves appearing radially arranged.
young or early leaf—early leaf growth, usually during spring on deciduous plants.
new leaf or early needle—early growth of new leaves or needles on evergreen plants.
full leaf—leaves fully grown with maximum physiological activity.
full needle—needles fully grown with maximum physiological activity.
mature leaf—leaves fully grown with cessation of physiological activity, usually during the fall.
color—the color change in the mature leaves of deciduous plants prior to the annual leaf fall.
no leaves—twigs or branches of deciduous plants following the annual leaf fall.
dormant—no growth occurring; plants mature or dry.
buds—leaf or flower buds showing; early development of leaf or flower.
flowering—having flowers; in bloom.
flowerstalk—the main stem of a plant on which the flower grows or is supported.
boot—early floral development in grasses; inflorescence or flower parts enclosed in the sheath near the uppermost leaves on the stems of grasses.
heads out—floral development in grasses; inflorescence out of the sheath but prior to anthesis.
fruit—seed bearing part of a plant.
early seed—early seed development; soon after anthesis (full bloom in flowers) but prior to the dough stage.
seed ripening—seed developing but not fully mature.
fruit ripe—fruit mature and fully developed but persistent on the plant.
seed disseminating, fruit dropping, or seedfall—seed or fruit fully developed, mature and disseminating from the plant.
[3]Plant not collected.
[4]Missing data.

Table A-4.—*Nutritional composition and in vitro dry matter digestibility (IVDMD) of selected woody plants during different stages of phenological development, Palustris Experimental Forest*

Average sample date/ species[1]	Stage of development[2]	IVDMD	Crude protein	Ether extract	Crude fiber	Nitrogen-free extract	Ash	Calcium	Phosphorus	Vitamin A
		percent								(IU/kg × 100)
April 20										
American beautyberry[3]	...	...	...	...	...	...	...	...	...	...
Flowering dogwood	early leaf/seed ripening	51.4	14.01	3.37	14.33	60.26	8.03	1.86	.14	257.33
Japanese honeysuckle[3]	...	...	...	...	...	...	...	...	...	...
Southern waxmyrtle	full leaf/seed ripening	24.5	14.38	3.89	16.22	62.27	3.24	.30	.13	529.73
Shining sumac	early leaf/full leaf	64.1	21.30	4.05	14.59	54.84	5.22	.38	.33	219.38
Sassafras	full leaf	42.1	20.49	4.67	20.49	49.68	4.67	.46	.22	739.92
Elliott blueberry	seed ripening	44.0	12.61	4.24	18.22	62.81	2.12	.31	.14	183.26
Summer grape	flower buds	44.1	20.04	3.61	14.10	56.10	6.15	1.06	.28	302.23
Longleaf pine	early needle	28.7	7.26	7.05	36.32	46.70	2.67	.20	.05	440.17
Loblolly pine	early needle	33.8	8.54	8.64	22.44	57.64	2.74	.26	.07	334.04
Common greenbriar[3]	...	...	...	...	...	...	...	...	...	...
May 21										
American beautyberry	full leaf	35.7	16.98	6.81	14.26	55.37	6.58	.64	.20	423.46
Flowering dogwood	full leaf/seed ripening	40.5	11.55	4.70	13.55	61.86	8.34	2.19	.14	379.22
Japanese honeysuckle	full leaf/ flowering	37.6	9.78	3.30	30.18	50.03	6.71	.62	.14	278.55
Southern waxmyrtle	full leaf/seed ripening	17.3	13.93	5.60	18.98	57.55	3.94	.67	.11	469.06
Shining sumac	full leaf	53.4	14.82	5.32	10.80	65.21	3.85	.34	.18	689.96
Sassafras	full leaf/seed ripening	35.8	18.98	4.81	19.31	51.54	5.36	.56	.33	617.73
Elliott blueberry	full leaf/fruit dropping	28.8	8.42	4.76	27.88	56.02	2.92	.56	.09	309.65
Summer grape	full leaf/seed ripening	34.9	16.51	3.88	15.83	55.87	7.91	1.26	.28	190.29
Longleaf pine	early needle	24.8	6.84	5.75	39.13	45.61	2.67	.14	.12	172.22
Loblolly pine	early needle	28.6	8.69	7.15	30.38	50.81	2.97	.20	.12	447.40
Common greenbriar	full leaf	50.2	14.56	3.92	32.07	44.65	4.80	.46	.22	259.26
June 27										
American beautyberry	full leaf/buds	29.7	10.93	6.95	16.23	59.82	6.07	.54	.13	24.28
Flowering dogwood	full leaf/seed development	36.3	10.49	6.60	13.72	59.14	10.05	2.64	.10	37.23
Japanese honeysuckle	full leaf/seed development	39.8	9.79	3.08	25.74	54.02	7.37	.92	.13	27.50
Southern waxmyrtle	full leaf/seed development	13.2	12.24	4.99	18.66	59.77	4.34	1.12	.07	43.88
Shining sumac	full leaf/seed development	45.0	9.75	6.13	16.43	65.06	2.63	.56	.09	104.05
Sassafras	full leaf/seed development	27.8	15.26	6.06	18.86	54.32	5.50	.76	.24	234.03
Elliott blueberry	full leaf/fruit dropping	23.3	10.73	6.08	26.06	54.07	3.06	.63	.11	27.90
Summer grape	full leaf/seed development	32.5	11.68	5.72	16.96	58.43	7.21	1.41	.15	71.65
Longleaf pine	full needle	23.0	6.36	7.38	41.20	42.23	2.83	.16	.10	43.92
Loblolly pine	early needle	27.6	8.96	7.66	32.59	47.53	3.26	.27	.14	65.68
Common greenbriar	full leaf	40.9	8.25	3.26	30.40	52.77	5.32	1.12	.09	38.00
July 27										
American beautyberry	full leaf/seed development	35.8	10.82	6.75	14.18	62.71	5.54	.60	.12	23.08
Flowering dogwood	full leaf/seed development	34.3	9.28	5.48	13.10	63.00	9.14	2.27	.08	84.87
Japanese honeysuckle	full leaf/seed development	35.5	9.70	3.82	30.14	49.04	7.30	.65	.19	139.54

Table A-4.—*Nutritional composition and in vitro dry matter digestibility (IVDMD) of selected woody plants during different stages of phenological development, Palustris Experimental Forest—Continued*

Average sample date/ species[1]	Stage of development[2]	IVDMD	Crude protein	Ether extract	Crude fiber	Nitrogen-free extract	Ash	Calcium	Phosphorus	Vitamin A
		percent								*(IU/kg × 100)*
Southern waxmyrtle	full leaf/seed development	12.7	12.07	5.79	23.14	54.84	4.16	.83	.07	231.51
Shining sumac	full leaf/seed development	45.7	8.86	9.99	13.29	63.70	4.16	.59	.10	503.84
Sassafras	full leaf/seed development	28.6	14.49	7.67	19.30	53.16	5.38	.67	.18	330.83
Elliott blueberry	full leaf	26.4	7.59	6.55	29.51	53.11	3.24	.56	.07	175.36
Summer grape	full leaf/fruit dropping	36.8	11.33	4.60	21.08	54.18	8.81	1.57	.13	171.59
Longleaf pine	full needle	24.9	6.37	7.62	39.44	43.75	2.82	.14	.09	287.31
Loblolly pine	full needle	26.5	7.05	9.34	33.80	46.56	3.25	.21	.10	331.37
Common greenbriar	full leaf/seed development	37.6	12.42	3.84	37.12	41.60	5.02	.50	.16	57.24
August 29										
American beautyberry	full leaf/seed development	37.1	10.28	6.89	16.50	60.31	6.02	.73	.12	78.77
Flowering dogwood	full leaf/seed development	38.6	10.89	10.09	11.44	59.13	8.45	2.40	.12	117.83
Japanese honeysuckle	full leaf/seed development	31.7	9.77	3.47	28.12	51.69	6.95	.77	.11	152.01
Southern waxmyrtle	full leaf/seed development	13.2	12.36	6.13	22.14	55.17	4.20	.96	.05	82.78
Shining sumac	full leaf/seed development	44.4	11.04	15.11	13.18	57.88	2.79	.50	.13	672.03
Sassafras	full leaf/seed development	25.2	14.50	6.47	17.64	56.21	5.18	.70	.12	240.17
Elliott blueberry	full leaf	28.6	8.07	5.76	25.38	57.19	3.60	.74	.07	78.57
Summer grape	full leaf/fruit ripe	40.7	9.74	4.58	16.60	61.92	7.16	1.58	.10	187.69
Longleaf pine	full needle	26.2	7.72	8.52	38.32	42.38	3.06	.15	.09	249.27
Loblolly pine	full needle	26.2	9.09	11.52	32.44	44.15	2.80	.20	.10	545.55
Common greenbriar	full leaf	41.4	7.42	3.55	33.12	49.67	6.24	1.16	.08	104.30
September 28										
American beautyberry	full leaf/fruit ripe	33.4	11.85	7.32	22.68	52.04	6.11	.98	.12	338.13
Flowering dogwood	full leaf/seed development	34.0	9.02	9.95	14.51	57.93	8.59	2.76	.10	485.00
Japanese honeysuckle	full leaf	35.4	10.46	2.74	26.59	52.91	7.30	.98	.16	23.31
Southern waxmyrtle	full leaf/seed development	13.9	12.65	6.71	20.42	55.30	4.92	1.45	.04	175.20
Shining sumac	color/fruit dropping	40.2	8.65	3.82	14.94	68.72	3.87	.78	.10	142.24
Sassafras	color	27.2	12.17	6.17	22.47	54.45	4.74	.99	.16	334.90
Elliott blueberry	full leaf	27.2	8.01	5.15	27.04	56.54	3.26	.85	.05	75.70
Summer grape	color	31.4	8.81	4.55	21.87	57.77	7.00	1.12	.09	482.08
Longleaf pine	full needle	23.9	6.12	5.88	38.05	46.70	3.25	.21	.07	312.40
Loblolly pine	full needle	24.2	7.86	8.14	29.57	50.90	3.53	.36	.08	598.59
Common greenbriar	full leaf/fruit ripe	33.0	8.88	1.78	36.74	47.82	4.78	.76	.12	77.77
November 3										
American beautyberry	color/fruit dropping	35.6	10.16	5.62	21.51	57.52	5.19	1.18	.11	[4]
Flowering dogwood	color/fruit ripe	44.1	9.34	21.87	13.91	46.39	8.49	2.12	.12	[4]
Japanese honeysuckle	full leaf/fruit dropping	42.6	8.16	2.90	37.49	45.43	6.02	1.06	.12	[4]
Southern waxmyrtle	full leaf/seed development	14.2	10.01	4.41	22.28	58.56	4.74	1.30	.04	[4]
Shining sumac	color/fruit dropping	44.2	8.57	5.36	15.01	67.63	3.43	.68	.08	[4]

Table A-4.—*Nutritional composition and in vitro dry matter digestibility (IVDMD) of selected woody plants during different stages of phenological development, Palustris Experimental Forest—Continued*

Average sample date/ species[1]	Stage of development[2]	IVDMD	Crude protein	Ether extract	Crude fiber	Nitrogen-free extract	Ash	Calcium	Phosphorus	Vitamin A
		percent								*(IU/kg×100)*
Sassafras	color	29.6	7.87	9.48	22.84	55.28	4.53	1.29	.08	[4]
Elliott blueberry	color	25.0	7.82	5.89	26.69	54.99	4.61	1.10	.06	[4]
Summer grape[3]	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Longleaf pine	full needle/ seed fall	25.7	7.83	6.12	38.20	44.95	2.90	.24	.10	[4]
Loblolly pine	full needle/ seed fall	26.9	9.77	9.02	28.46	49.64	3.11	.28	.13	[4]
Common greenbriar	full leaf/ fruit dropping	29.4	6.31	2.67	44.60	42.03	4.39	.71	.07	[4]
December 12										
American beautyberry	color/fruit dropping	29.4	7.84	4.13	34.88	45.44	7.71	.76	.09	37.00
Flowering dogwood	no leaves/fruit dropping	30.4	6.72	5.94	20.16	59.08	8.10	2.20	.08	79.71
Japanese honeysuckle	full leaf/fruit dropping	35.7	9.10	2.86	34.08	47.87	6.09	.85	.12	121.06
Southern waxmyrtle	full leaf/fruit dropping	15.5	10.38	6.66	21.76	56.76	4.44	1.34	.04	66.52
Shining sumac	color/fruit dropping	34.9	6.60	5.97	27.78	54.85	4.80	1.00	.11	157.41
Sassafras	color	25.5	5.64	4.84	39.90	46.58	3.04	.72	.08	153.58
Elliott blueberry	color	19.2	5.99	7.24	34.54	48.14	4.09	.94	.05	55.05
Summer grape[3]	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Longleaf pine	full needle/ seed fall	23.9	6.78	7.67	38.82	43.17	3.56	.18	.08	355.84
Loblolly pine	full needle/ seed fall	25.7	9.50	11.92	29.76	45.01	3.81	.30	.11	571.01
Common greenbriar	full leaf/ fruit dropping	32.2	9.89	3.75	36.85	45.15	4.36	.61	.10	158.06
January 27										
American beautyberry[3]	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Flowering dogwood	. . .	33.7	6.55	5.15	26.29	53.53	8.48	2.40	.09	59.01
Japanese honeysuckle	. . .	53.1	12.27	4.63	17.33	57.91	7.86	1.44	.14	185.15
Southern waxmyrtle	. . .	16.2	11.19	6.57	18.30	58.34	5.60	1.64	.04	51.67
Shining sumac	color	25.3	6.18	5.97	46.06	37.42	4.37	1.10	.10	490.41
Sassafras	color	28.7	6.73	5.24	39.53	45.94	2.56	.56	.10	131.41
Elliott blueberry	flower buds	16.3	6.70	2.66	43.46	44.63	2.55	.73	.04	39.32
Summer grape[3]	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Longleaf pine	full needle/buds	27.8	7.89	8.64	34.86	45.94	2.67	.26	.07	61.83
Loblolly pine	full needle/buds	26.1	8.32	10.78	25.83	52.19	2.88	.31	.09	784.42
Common greenbriar[3]	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .

Table A-4.—*Nutritional composition and in vitro dry matter digestibility (IVDMD) of selected woody plants during different stages of phenological development, Palustris Experimental Forest—Continued*

Average sample date/ species[1]	Stage of development[2]	IVDMD	Crude protein	Ether extract	Crude fiber	Nitrogen-free extract	Ash	Calcium	Phosphorus	Vitamin A
		percent								*(IU/kg × 100)*
February 27										
American beautyberry	no leaves	26.4	6.26	1.10	48.30	41.22	3.12	.44	.06	10.68
Flowering dogwood	no leaves/buds	36.5	8.29	4.37	27.15	52.65	7.54	2.54	.13	116.02
Japanese honeysuckle	full leaf	43.2	11.31	2.50	33.88	46.95	5.36	.72	.15	184.91
Southern waxmyrtle	early leaf/buds	14.1	11.56	5.38	21.76	56.40	4.90	1.31	.05	269.93
Shining sumac	no leaves/buds	27.2	6.56	6.19	35.16	46.75	5.34	1.28	.11	127.32
Sassafras	buds	24.7	5.23	2.48	49.70	40.25	2.34	.43	.08	85.49
Elliott blueberry	early leaf/buds	15.3	5.55	3.72	39.56	48.48	2.69	.67	.06	64.52
Summer grape	no leaves	22.4	6.55	1.39	45.28	42.92	3.86	.67	.12	158.80
Longleaf pine	full needle	28.2	6.57	7.24	36.29	46.81	3.09	.26	.07	512.32
Loblolly pine	full needle	30.8	8.74	10.17	25.06	53.02	3.01	.36	.11	565.18
Common greenbriar	full leaf	27.0	8.60	2.50	41.16	43.70	4.04	.58	.09	30.75

[1]Scientific nomenclature given in appendix table A-1.

[2]Stages of development:

rosette—a cluster of basal leaves appearing radially arranged.
young or early leaf—early leaf growth, usually during spring on deciduous plants.
new leaf or early needle—early growth of new leaves or needles on evergreen plants.
full leaf—leaves fully grown with maximum physiological activity.
full needle—needles fully grown with maximum physiological activity.
mature leaf—leaves fully grown with cessation of physiological activity, usually during the fall.
color—the color change in the mature leaves of deciduous plants prior to the annual leaf fall.
no leaves—twigs or branches in deciduous plants following the annual leaf fall.
dormant—no growth occurring; plants mature or dry.
buds—leaf or flower buds showing; early development of leaf or flower.
flowering—having flowers; in bloom.
flowerstalk—the main stem of a plant on which the flower grows or is supported.
boot—early floral development in grasses; inflorescence or flower parts enclosed in the sheath near the uppermost leaves on the stems of grasses.
heads out—floral development in grasses; inflorescence out of the sheath but prior to anthesis.
fruit—seed bearing part of a plant.
early seed—early seed development; soon after anthesis (full bloom in flowers) but prior to the dough stage.
seed ripening—seed developing but not fully mature.
fruit ripe—fruit mature and fully developed but persistent on the plant.
seed disseminating, fruit dropping, or seedfall—seed or fruit fully developed, mature and disseminating from the plant.

[3]Plant not collected.

[4]Missing data.

Table A-5.—*Botanical composition (percent) of cattle diets (1971-74) by cage, esophageal, and fecal estimates*[1]

Species or forage class	April 20				May 21				June 27			
	Cage	Macro-Esoph	Micro-Esoph	Fecal	Cage	Macro-Esoph	Micro-Esoph	Fecal	Cage	Macro-Esoph	Micro-Esoph	Fecal
Grasses	66	70	64	77	87	80	80	76	88	80	77	80
Bluestems	55	...	41	49	65	...	49	47	75	...	44	48
Pinehill blustem	52	...	...	...	57	...	...	...	66	...	...	...
Slender bluestem	3	...	...	...	8	...	...	...	9	...	...	...
Big bluestem	...	...	...	...	T[2]	...	...	...	...	...	...	...
Green silkyscale	1	...	...	...	2	...	3	1	3	...	2	2
Cutover muhly	2	...	...	...	3	...	T	4	4	...	2	1
Panicums	6	...	16	12	9	...	15	13	3	...	16	15
Paspalums	...	...	1	1	3	...	3	1	1	...	4	1
Other grasses	2	...	...	...	5	...	...	...	2	...	...	...
Arrowfeather threeawn	...	...	1	6	...	...	2	5	...	...	2	5
Common carpetgrass	...	...	...	...	...	...	...	...	...	...	...	...
Purple lovegrass	...	...	2	3	...	...	3	3	...	...	3	3
Bearded skeletongrass	...	...	2	2	...	...	2	1	...	...	2	2
Carolina jointtail	...	...	T	1	...	...	...	...	...	...	...	...
Pineywoods dropseed	...	...	1	3	...	...	1	1	...	...	2	3
Purpletop tridens	...	...	...	...	...	...	...	...	...	...	...	...
Longleaf uniola	...	...	...	...	...	...	...	...	...	...	...	...
Unidentified grasses	...	...	...	T	...	...	2	...	...	...	...	...
Grasslikes	0	0	1	3	1	T	2	11	T	T	3	3
Forbs	34	27	7	0	13	13	12	8	12	18	23	11
Swamp sunflower	2	...	...	...	4	...	1	1	6	...	4	2
Other composites	1	...	...	...	3	...	...	...	1	...	...	...
Ragweed woollywhite	...	...	7	...	...	...	2	1	...	...	6	1
Unidentified composites	...	...	...	...	...	...	3	2	...	...	2	4
Tephrosias	2	...	...	...	2	...	T	...	2	...	...	...
Other legumes	T	...	...	...	2	...	...	...	1	...	...	...
Littleleaf tickclover	...	...	...	...	...	...	T	1	...	...	...	...
Hairy rhynchosia	...	...	...	...	...	...	...	T	...	...	...	...
Pencilflower	...	...	...	...	...	...	1	...	...	...	T	...
Unidentified legumes	...	...	...	...	...	...	3	2	...	...	3	3
Other forbs	28	...	...	...	1	...	...	...	3	...	...	...
Poor-joe	...	...	...	...	...	...	1	T	...	...	7	1
Southern bracken	...	...	...	...	...	...	...	...	...	...	T	...
Pines	0	1	2	13	0	2	4	3	0	1	2	8
Other woody plants	0	1	26	7	0	3	5	6	0	1	4	3
American beautyberry	...	...	...	1	...	...	1	T	...	...	1	...
Flowering dogwood	...	...	8	2	...	...	1	1	...	...	1	...
Japanese honeysuckle	...	...	...	...	...	...	...	T	...	...	1	...
Southern waxmyrtle	...	...	1	...	...	...	T	T	...	...	...	...
Oaks	...	...	...	1	...	...	1	1	...	...	...	...
Shining sumac	...	...	1	1	...	...	T	1	...	...	...	1
Blackberry	...	...	...	...	...	...	T	...	...	...	...	1
Sassafras	...	...	...	...	...	...	...	T	...	...	T	...
Elliott blueberry	...	...	...	...	...	...	...	T	...	...	...	...
Summer grape	...	...	7	2	...	...	1	1	...	...	T	1
Unidentified browse	...	...	9	...	...	...	...	T	...	...	...	...

July 27				August 29				September 28				November 3			
Cage	Macro-Esoph	Micro-Esoph	Fecal	Cage	Macro-Esoph	Micro-Esoph	Fecal	Cage	Macro-Esoph	Micro-Esoph	Fecal	Cage	Macro-Esoph	Micro-Esoph	Fecal
79	85	83	74	82	85	92	91	80	70	75	70	85	60	72	73
53	...	56	44	60	...	58	60	42	...	49	35	55	...	45	39
45	...	...	...	48	...	...	...	29	...	...	...	44	...	...	...
8	...	...	...	5	...	...	...	12	...	...	...	9	...	...	...
...	...	...	...	1	...	...	...	T	...	...	...	...	...	...	...
6	...	1	1	4	...	4	2	5	...	T	T	4	...	...	...
1	...	...	T	1	...	2	1	2	...	1	1	4	...	2	2
9	...	12	14	3	...	8	11	9	...	15	14	10	...	13	12
2	...	2	1	2	...	3	2	1	...	1	1	...	...	1	2
7	...	...	...	13	...	...	...	20	...	...	...	12	...	...	...
...	...	4	5	...	...	4	7	...	...	2	9	...	...	2	7
...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...
...	...	3	3	...	...	6	2	...	...	4	4	...	...	5	3
...	...	1	4	...	...	2	2	...	...	1	3	...	...	1	3
...	...	1	...	...	...	1	...	...	...	...	...	...	...	...	...
...	...	3	2	...	...	3	4	...	...	2	3	...	...	1	5
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	T	T	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	T	T	...	...	...	...
T	T	1	3	0	0	1	1	0	T	1	2	0	0	2	1
21	14	13	6	18	12	8	7	20	21	5	7	15	26	18	10
10	...	2	1	10	...	1	2	11	...	...	...	7	...	...	...
1	...	...	...	T	...	...	...	2	...	...	...	6	...	...	...
...	...	3	1	...	...	2	1	...	...	2	2	...	...	5	3
...	...	5	2	...	...	3	3	...	...	2	3	...	...	10	4
T	...	...	...	T	...	...	...	T	...	...	...	...	...	...	...
3	...	...	...	1	...	...	...	T	...	...	...	T	...	...	...
...	...	T	...	...	...	1	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	T	...	...	...	T	...	...	...	T	...	...	...	...	...
...	...	1	1	...	...	1	1	...	...	T	2	...	...	3	2
7	...	...	...	6	...	...	...	6	...	...	...	1	...	...	...
...	...	1	1	...	...	...	...	...	...	T	...	...	...	...	...
...	...	...	...	...	...	...	T	...	...	...	T	...	...	...	1
0	2	3	12	0	3	3	5	0	4	5	8	0	6	7	15
0	T	2	4	0	T	3	5	0	2	11	12	0	4	8	7
...	...	T	1	...	...	T	1	...	...	4	2	...	...	2	1
...	...	T	...	...	...	T	T	...	...	2	2	...	...	...	1
...	...	T	...	...	...	...	...	...	...	T	2	...	...	2	...
...	...	...	...	...	...	...	...	...	...	...	1	...	...	2	2
...	...	T	...	...	...	...	...	...	...	2	1	...	...	1	1
...	...	T	1	...	...	T	1	...	...	2	1	...	...	1	1
...	...	1	1	...	...	T	1	...	...	...	2	...	...	...	...
...	...	...	1	...	...	1	1	...	...	...	1	...	...	...	1
...	...	...	...	...	...	T	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	1	...	...	1	...	...	...	...	...

Table A–5.—*Botanical composition (percent) of cattle diets (1971-74) by cage, esophageal, and fecal estimates*[1]*—Continued*

Species or forage class	December 12				January 27				February 27			
	Cage	Macro-Esoph	Micro-Esoph	Fecal	Cage	Macro-Esoph	Micro-Esoph	Fecal	Cage	Macro-Esoph	Micro-Esoph	Fecal
Grasses	89	53	66	76	92	52	51	48	87	53	64	69
Bluestems	48	...	36	42	48	...	33	27	43	...	38	31
Pinehill bluestem	39	...	...	...	45	...	...	...	34	...	...	...
Slender bluestem	8	...	...	...	2	...	...	...	9	...	...	...
Big bluestem	...	...	...	...	...	...	...	...	...	...	...	...
Green silkyscale	T	...	T	...	...	...	...	...	...	...	1	1
Cutover muhly	4	...	1	8	13	...	...	5	6	...	3	5
Panicums	20	...	13	14	11	...	10	5	31	...	12	17
Paspalums	T	...	T	...	T	...	1	T	T	...	1	T
Other grasses	17	...	...	...	22	...	...	...	7	...	...	...
Arrowfeather threeawn	...	...	3	5	...	...	1	2	...	...	2	...
Common carpetgrass	...	...	1	T	...	...	...	...	...	...	...	2
Purple lovegrass	...	...	7	4	...	...	4	3	...	...	5	5
Bearded skeletongrass	...	...	2	1	...	...	1	1	...	...	T	4
Carolina jointtail	...	...	...	...	...	...	...	...	...	...	...	...
Pineywoods dropseed	...	...	2	2	...	...	1	4	...	...	2	4
Purpletop tridens	...	...	T	...	...	...	...	...	...	...	...	...
Longleaf uniola	...	...	...	...	...	...	...	...	...	...	...	...
Unidentified grasses	...	...	...	...	...	...	...	...	...	...	T	...
Grasslikes	0	1	1	1	T	0	1	18	2	T	5	1
Forbs	12	7	9	2	7	21	19	1	11	23	8	0
Swamp sunflower	1	...	...	...	...	...	...	...	T	...	...	...
Other composites	8	...	...	...	7	...	...	...	10	...	...	...
Ragweed woollywhite	...	...	8	2	...	...	19	1	...	...	8	...
Unidentified composites	...	...	1	...	...	...	...	...	...	...	...	...
Tephrosias	...	...	...	...	...	...	...	...	...	...	...	...
Other legumes	1	...	...	...	...	...	...	...	1	...	...	...
Littleleaf tickclover	...	...	...	...	...	...	...	...	...	...	...	...
Hairy rhynchosia	...	...	...	...	...	...	...	...	...	...	...	...
Pencilflower	...	...	...	...	...	...	...	...	...	...	...	...
Unidentified legumes	...	...	T	...	...	...	...	...	...	...	...	...
Other forbs	1	...	...	...	...	...	...	...	T	...	...	...
Poor-joe	...	...	...	...	...	...	...	...	...	...	...	...
Southern bracken	...	...	...	T	...	...	...	...	...	...	...	...
Pines	0	18	10	14	0	14	13	18	0	16	10	10
Other woody plants	0	22	23	13	0	13	16	11	0	8	19	8
American beautyberry	...	...	...	...	...	...	...	1	...	...	...	...
Flowering dogwood	...	...	4	2	...	...	1	...	...	...	1	4
Japanese honeysuckle	...	...	1	...	...	...	...	...	...	...	1	...
Southern waxmyrtle	...	...	5	5	...	...	10	6	...	...	12	3
Oaks	...	...	T	3	...	...	...	...	...	...	1	...
Shining sumac	...	...	T	T	...	...	5	4	...	...	2	1
Blackberry	...	...	12	2	...	...	...	...	...	...	2	...
Sassafras	...	...	...	...	...	...	...	...	...	...	...	...
Elliott blueberry	...	...	...	1	...	...	...	...	...	...	...	...
Summer grape	...	...	...	...	...	...	...	...	...	...	...	...
Unidentified browse	...	...	...	...	...	...	...	...	...	...	...	...

[1]Cage: cage estimates
Macro Esoph: gross morphological estimates of esophageal samples
Micro Esoph: microhistological estimates of esophageal samples
Fecal: microhistological estimates of fecal samples
[2]T = less than 0.5%

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PEARSON, H. A., H. E. GRELEN, E. A. EPPS, M. K. JOHNSON, and B. W. BLAKEWOOD.

1982. Botanical composition and nutritive value of cattle diets on southern pine range. U.S. Dep. Agric. For. Serv. Res. Pap. SO-178, 24 p. South. For. Exp. Stn., New Orleans, La.

The botanical composition of the cattle diet and the nutritive value of about 50 herbaceous and woody diet components are sampled and reported for the longleaf pine-bluestem range in Louisiana. Digestibility is also related to the diet.